

# INTERNATIONAL STANDARD

**Multimedia systems and equipment – Colour measurement and management –  
Part 2-4: Colour management – Extended-gamut YCC colour space for video  
applications – xvYCC**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MULTIMEDIA SYSTEMS AND EQUIPMENT –  
COLOUR MEASUREMENT AND MANAGEMENT –**

**Part 2-4: Colour management –  
Extended-gamut YCC colour space  
for video applications – xvYCC**

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International Standard IEC 61966-2-4 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

The text of this standard is based on the following documents:

CDV	Report on voting
100/967/CDV	100/1026/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61966 consists of the following parts, under the general title *Multimedia systems and equipment – Colour measurement and management*:

- Part 2-1: Colour management – Default RGB colour space – sRGB
- Part 2-2: Colour management – Extended RGB colour space – scRGB
- Part 2-4: Colour management – Extended-gamut YCC colour space for video applications – xvYCC
- Part 2-5: Colour management – Optional RGB colour space – opRGB (under consideration)
- Part 3: Equipment using cathode ray tubes
- Part 4: Equipment using liquid crystal display panels
- Part 5: Equipment using plasma display panels
- Part 6: Front projection displays
- Part 7-1: Colour printers – Reflective prints – RGB inputs
- Part 7-2: Colour printers – Reflective prints – CMYK inputs (proposed work item)
- Part 8: Multimedia colour scanners
- Part 9: Digital cameras
- Part 10: Quality assessment (proposed work item)
- Part 11: Quality assessment – Impaired video in network systems (proposed work item)

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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A bilingual version of this publication may be issued at a later date.

The contents of the corrigendum of November 2006 have been included in this copy.

## INTRODUCTION

After the publication of IEC 61966-2-1, Amendment 1, the sYCC colour encoding was used to capture, store and print extended colour gamut for still image applications. Users received pleasant benefit by exchanging and reproducing wide-gamut colour images.

Recently, various kinds of displays that are capable of producing a wider gamut of colour than the conventional CRT-based displays are emerging. However, most of the current video contents that are displayed on conventional displays, are rendered for the sRGB-gamut. Users of wide-gamut displays could benefit from wide-gamut colour images by video colour encoding that supports a larger colour gamut.

This standard defines the “extended-gamut YCC colour space for video applications”. It is based on the current implementation of YCC colour encoding that is used in the video industry (namely ITU-R BT.709-5) and extends its definition to the wider gamut of colour range.

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# MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

## Part 2-4: Colour management – Extended-gamut YCC colour space for video applications – xvYCC

### 1 Scope

This part of IEC 61966 is applicable to the encoding and communication of YCC colours used in video systems and similar applications by defining encoding transformations for use in defined reference capturing conditions. If actual conditions differ from the reference conditions, additional rendering transformations may be required. Such additional rendering transformations are beyond the scope of this standard.

### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-845:1987, *International Electrotechnical Vocabulary (IEV) – Part 845: Lighting*

ITU-R Recommendation BT.601-5:1995, *Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios*

ITU-R Recommendation BT.709-5:2002, *Parameter values for the HDTV standards for production and international programme exchange*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those concerning illuminance, luminance, tristimulus, and other related lighting terms given in IEC 60050-845, apply.

#### 3.1

##### **scene-referred colour encoding**

representation of estimated colour-space coordinates of the elements of an original scene, where a scene is defined to be the relative spectral radiance

#### 3.2

##### **output-referred colour encoding**

representation of estimated colour-space coordinates of image data that are appropriate for specified output device and viewing conditions

#### 3.3

##### **extended gamut**

colour gamut extending outside that of the standard sRGB CRT display defined in IEC 61966-2-1



### 3.4

#### **luma**

luminance signal as defined by SMPTE/EG28:1993

NOTE 1 To avoid interdisciplinary confusion resulting from the two distinct definitions of luminance, it has been proposed that the video documents use “luma” for “luminance, television” (i.e., the luminance signal).

NOTE 2 Video systems approximate the lightness response of vision by computing a luma component  $Y'$  as a weighted sum of non-linear (or gamma-corrected)  $R'G'B'$  primary components. Luma is often carelessly referred to as luminance.

## 4 Colorimetric parameters and related characteristics

This clause defines colorimetric parameters and the related characteristics of reference capturing devices.

### 4.1 Primary colours and reference white

The CIE chromaticities for the reference red, green, and blue primary colours, and for reference white CIE standard illuminant D65, are given in Table 1. These primaries and white point values are identical to those of ITU-R BT.709-5.

**Table 1 – CIE chromaticities for reference primary colours and reference white**

	Red	Green	Blue	White/D65
$x$	0,640 0	0,300 0	0,150 0	0,312 7
$y$	0,330 0	0,600 0	0,060 0	0,329 0
$z$	0,030 0	0,100 0	0,790 0	0,358 3

### 4.2 Opto-electronic transfer characteristics

Opto-electronic transfer characteristics are defined as follows.

If  $R, G, B \leq -0,018$ ,

$$\begin{aligned}
 R' &= -1,099 \times (-R)^{0,45} + 0,099 \\
 G' &= -1,099 \times (-G)^{0,45} + 0,099 \\
 B' &= -1,099 \times (-B)^{0,45} + 0,099
 \end{aligned}
 \tag{1}$$

If  $-0,018 < R, G, B < 0,018$ ,

$$\begin{aligned}
 R' &= 4,50 \times R \\
 G' &= 4,50 \times G \\
 B' &= 4,50 \times B
 \end{aligned}
 \tag{2}$$

If  $R, G, B \geq 0,018$ ,

$$\begin{aligned}
 R' &= 1,099 \times (R)^{0,45} - 0,099 \\
 G' &= 1,099 \times (G)^{0,45} - 0,099 \\
 B' &= 1,099 \times (B)^{0,45} - 0,099
 \end{aligned}
 \tag{3}$$

where  $R, G, B$  is a voltage normalized by reference white level and proportional to the implicit light intensity that would be detected with a reference camera colour channel;  $R', G', B'$  is the resulting non-linear primary signal.

### 4.3 YCC (luma-chroma-chroma) encoding methods

The encoding equations from the primary RGB (red-green-blue) signal:  $R', G', B'$  to the YCC (luma-chroma-chroma) signal:  $Y', Cb', Cr'$  is defined by the following two methods. It is important to follow one of the encodings in the specified application.

$xvYCC_{601}$ , which is implemented mainly in the SDTV (standard-definition television) applications as defined in ITU-R BT. 601-5, is defined as follows:

$$\begin{bmatrix} Y'_{601} \\ Cb'_{601} \\ Cr'_{601} \end{bmatrix} = \begin{bmatrix} 0,299\ 0 & 0,587\ 0 & 0,114\ 0 \\ -0,168\ 7 & -0,331\ 3 & 0,500\ 0 \\ 0,500\ 0 & -0,418\ 7 & -0,081\ 3 \end{bmatrix} \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} \quad (4)$$

NOTE The coefficients in equation (4) are from ITU-R BT.601-5 which defines  $Y'$  of YCC to the three decimal place accuracy. An additional decimal place is defined above to be consistent with the other matrix coefficients defined in this standard.

$xvYCC_{709}$ , which is implemented mainly in the HDTV (high-definition television) applications as defined in ITU-R BT. 709-5, is defined as follows:

$$\begin{bmatrix} Y'_{709} \\ Cb'_{709} \\ Cr'_{709} \end{bmatrix} = \begin{bmatrix} 0,212\ 6 & 0,715\ 2 & 0,072\ 2 \\ -0,114\ 6 & -0,385\ 4 & 0,500\ 0 \\ 0,500\ 0 & -0,454\ 2 & -0,045\ 8 \end{bmatrix} \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} \quad (5)$$

### 4.4 Digital quantization methods

Quantization of YCC (luma-chroma-chroma) signal:  $Y', Cb', Cr'$  is defined as follows.

For 8-bit representation:

$$\begin{aligned} Y_{xvYCC(8)} &= \text{round}[219 \times Y' + 16] \\ Cb_{xvYCC(8)} &= \text{round}[224 \times Cb' + 128] \\ Cr_{xvYCC(8)} &= \text{round}[224 \times Cr' + 128] \end{aligned} \quad (6)$$

For  $n$ -bit ( $n > 8$ ) representation:

$$\begin{aligned} Y_{xvYCC(N)} &= \text{round}[(219 \times Y' + 16) \times 2^{n-8}] \\ Cb_{xvYCC(N)} &= \text{round}[(224 \times Cb' + 128) \times 2^{n-8}] \\ Cr_{xvYCC(N)} &= \text{round}[(224 \times Cr' + 128) \times 2^{n-8}] \end{aligned} \quad (7)$$

NOTE Bit levels “from 0 to  $2^{N-8}-1$ ” and “from  $255 \times 2^{N-8}$  to  $2^N-1$ ” (0 and 255, for the case of 8-bit encoding) are used exclusively for synchronization and are not allowed for storing colour values. Levels from “ $2^{N-8}$ ” to “ $255 \times 2^{N-8}-1$ ” (from 1 to 254, for the case of 8-bit encoding) are available.